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## EUROPEAN PATENT APPLICATION

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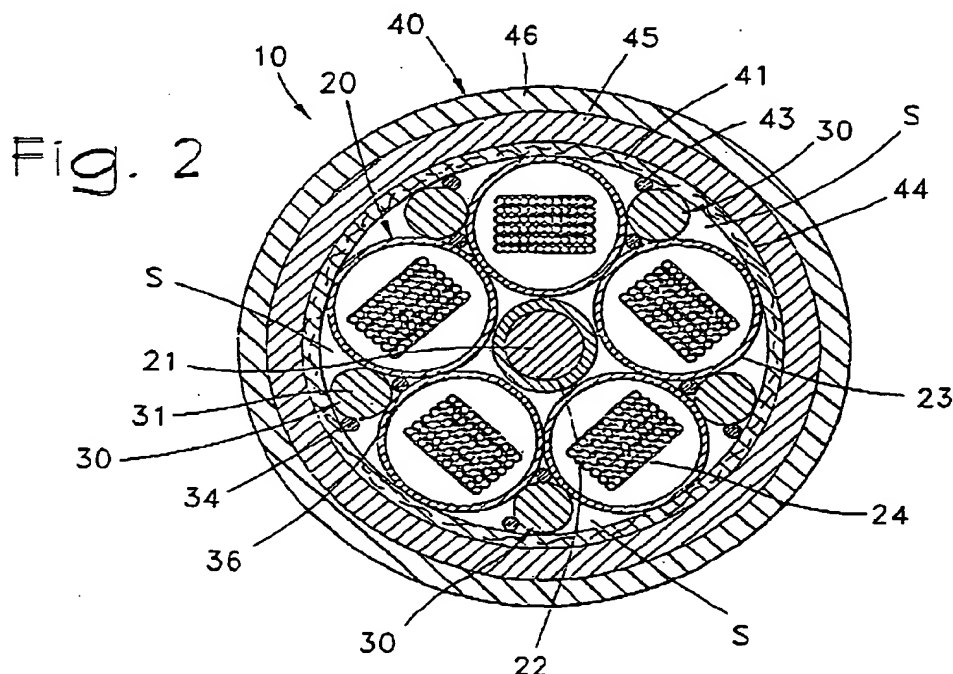
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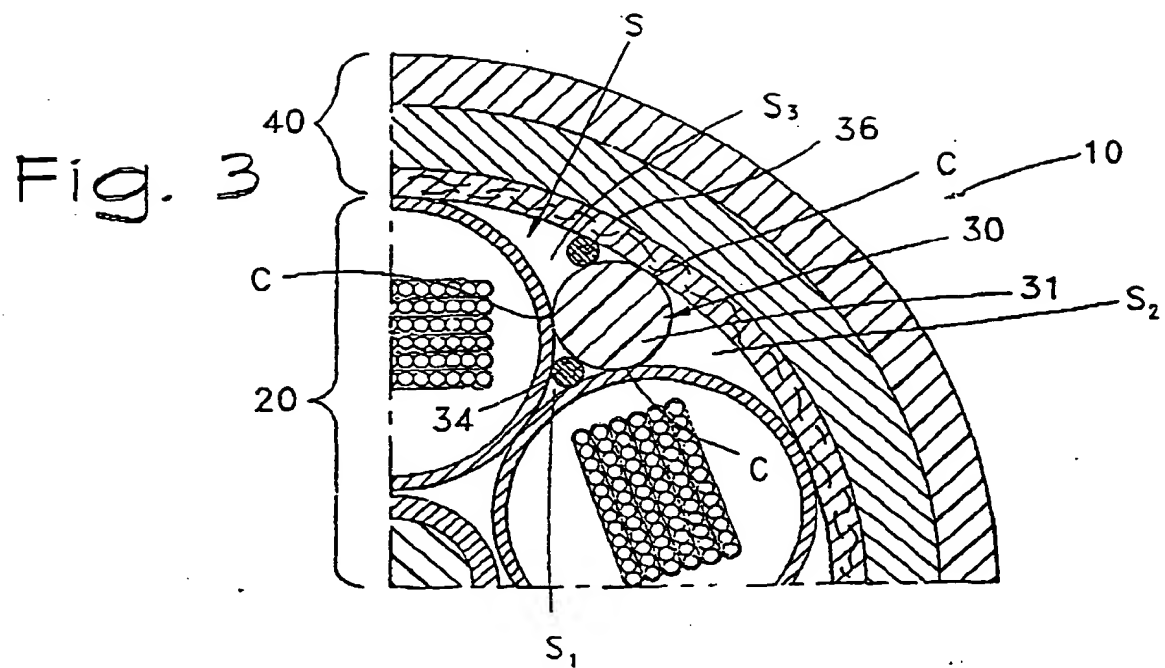
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(54) Fibre optic cable

(57) A fiber optic cable (10) includes a tube section (20) and an sheath section (40). Between tube and sheath sections (20,40) is a series of general interstices (S), each general interstice (S) comprises a respective

set of sub-interstices (S1,S2,S3). Each general interstice (S) comprises a respective interstitial assembly (30). Each interstitial assembly (30) provides crush strength resistance and water blocking features to fiber optic cable (10).





## Description

The present invention relates to a fiber optic cable having compressive strength members for high crush strength, and having water blocking members for preventing water migration in the cable.

## BACKGROUND OF THE INVENTION

Fiber optic cables include optical fibers which transmit signals for cable television, computer, and telephone networks. Fiber optic cables are used in indoor and outdoor environments. The outdoor environment exposes the cable to the possibility of being flooded, or otherwise submerged in water. If the cable has leak-paths caused by fatigue, rodents or otherwise, the migration of water in the cable may cause failure of the cable components. Moreover, longitudinal water migration within the cable may cause the cable to act as a conduit, thereby flooding rooms or compartments to which the cable runs.

Fiber optic cables may be subjected to extrinsic compressive forces, for example, from cable support clamps or, for buried cable, the weight of earth and stone. A given cable must be robust enough to withstand such extrinsic forces. In the event that water migrates through the cable, or the cable experiences an overload of compressive forces, the ability of the optical fibers to transmit signals may be reduced or altogether eliminated.

To ensure that fiber optic cables are protected, cable components have been developed to inhibit water migration, and to resist compressive forces. Such features comprise a water impermeable medium for inhibiting water migration, and compressive strength members for increasing the crush strength of the cable. Water impermeable mediums, also known as flooding compounds, generally comprise a greasy or jelly-like substance which is applied in the interstices between components inside the cable. However, where fibers in the cable are to be terminated to a connector or the cable network is to be modified, the craftsman must remove the flooding compound from the cable components with chemical de-greasing agents. This is a potentially messy and a time-consuming process, especially in tight sheath, mid-span access operations. Moreover, manufacturing processes designed to apply the flooding compound to the cable components may be unsuccessful in completely filling each interstice, thereby leaving the possibility of water migration through non-filled interstice portions. To compound the problem, where compressive strength members are used the compressive strength members will generally increase the number of non-filled interstice portions.

Examples of conventional fiber optic cables are disclosed in GB Patent Specification 1601004, some of which cables include compressive strength members. In the examples where compressive strength members and a water impermeable medium are used in combi-

nation there are isolated non-filled interstice portions. Moreover, the recommended water impermeable medium is petroleum jelly, which, as noted above, is a messy and time-consuming substance to remove.

## OBJECTS OF THE INVENTION

In view of the foregoing, it is an object of the present invention to provide a fiber optic cable which meets water migration and crush strength specifications without the necessity for a greasy water impermeable material.

It is a further object of the invention to provide a fiber optic cable having a water swellable material strategically located in an interstice thereof.

It is another object of the present invention to provide a fiber optic cable with water swellable members associated with respective compressive strength members, which water swellable members are arranged to inhibit the migration of water in sub-interstices adjacent to the compressive strength members.

It is a further object of the invention to provide a fiber optic cable having compressive strength members with water blocking members stranded therearound or alongside the compressive strength member.

## BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows an isometric view of a fiber optic cable according to the present invention.

Figure 2 shows a cross sectional view of the fiber optic cable of Figure 1 taken along line 2-2.

Figure 3 shows a section of the fiber optic cable of Figure 2.

Figure 4 is an illustrative view of the fiber optic cable of Figure 3.

Figure 5 is a section of a fiber optic cable according to a second embodiment of the present invention.

Figure 6 is a section of a fiber optic cable according to a further embodiment of the present invention.

## DETAILED DESCRIPTION OF THE INVENTION

Referring to Figures 1-3, a fiber optic cable 10 according to the present invention will be described. Fiber optic cable 10 includes a tube section 20 and sheath section 40. Between tube and sheath sections 20 and 40 is a series of general interstices S (Figure 2), each general interstice S comprises respective sub-interstices S1, S2, S3 (Figure 4). Additionally, each general interstice S contains a respective interstitial assembly 30 (Figure 2) strategically disposed therein. Interstitial assemblies 30 advantageously contribute to the crush strength and water inhibiting features of fiber optic cable 10.

Tube section 20 includes a central strength member 21 formed of a dielectric material. Central strength member 21 is surrounded by a water swellable tape material 22. A plurality of carrier members comprising buffer

tubes 23 surround tape 22. Each buffer tube 23 includes optical fiber ribbons 24 with optical fibers 25 therein, for example, optical fiber ribbons made by Siecor Corporation, of Hickory, North Carolina. Buffer tubes 23 are preferably S-Z stranded about central strength member 21 in a conventional S-Z stranding manufacturing process. Where the optical fiber count so requires, solid filler rods may be substituted for buffer tubes 23. In either event, tube section 20 is bound together with a binder 26.

Sheath section 40 includes a water swellable tape material 41 which surrounds tube section 20. Tape material 41 is bound by a binder 42. Sheath section 40 is provided with a conventional rip cord 43 and dielectric tensile strength members 44. An armor tape material 45 surrounds rip cord 43 and dielectric strength members 44. A durable outer jacket 46 completes sheath section 40.

As best shown by Figure 3, a typical interstitial assembly 30 according to the present invention comprises a cable reinforcing member, for example, a compressive strength member 31. Compressive strength member 31 is formed of a solid material, for example, a dielectric material, e.g. a low or medium density polyethylene material or a polypropylene material. Interstitial assembly 30 also comprises conventional water swellable members, for example, commercially available elongated water swellable yarns 34 and 36. Water swellable yarns 34 and 36 are generally helically stranded about compressive strength member 31, but yarns 34 and 36 are stranded in opposite directions.

As best shown in Figure 2, fiber optic cable 10 comprises a series of interstitial assemblies 30 disposed in general interstices S between tube section 20 and sheath section 40. Each interstitial assembly 30 is stranded into a respective general interstice S during the S-Z stranding manufacturing process. For illustrative purposes, a section of a cable 10 is shown in Figure 4 with an interstitial assembly 30 removed, but having the profile of compressive strength member 31 shown in a phantom line within general interstice S. As noted above, general interstice S is defined between tube section 20 and sheath section 40. Each general interstice S comprises a set of generally discrete sub-interstices S1, S2, S3. Sub-interstice S1 is, relative to the center of cable 10, located generally radially inwardly of sub-interstices S2 and S3. However, sub-interstice S1 may be isolated, i.e. it is generally not in communication with either of sub-interstices S2 or S3. This is because points of contact, indicated as points C in Figure 3, preferably exist between compressive strength member 31 and respective adjacent buffer tubes 23 and tape 41. The contact of tubes 23 with compressive strength member 31 generally isolates sub-interstice S1 from sub-interstices S2 and S3.

In a first embodiment of the present invention, water swellable yarns 34 and 36 are generally helically stranded about a respective compressive strength member 31. For example, along certain lengths of cable 10, yarn

34 will occupy sub-interstice S1 (Figure 3), but its helical lay runs it about member 31 until it passes sub-interstice S2 and arrives at sub-interstice S3. Yarn 34 and yarn 36 are stranded in opposite directions, whereby yarn 36 moves from sub-interstice S3 (Figure 3) to the position formerly occupied by yarn 34, i.e. it moves into sub-interstice S1, but its helical lay runs it about member 31 until it passes sub-interstice S2 and arrives back at sub-interstice S3. Thus along the length of cable 10, yarns 34 and 36 will preferably alternately occupy sub-interstices S1, S2, S3. The stranding of yarns 34 and 36 in generally opposite directions about compressive member 31 results in a series of cross-over points 38 (Figure 1), i.e. where the yarns come in contact with each other.

In operation, yarns 34 and 36 will swell when in contact with water and thereby block water migrating in any of sub-interstices S1, S2, or S3. If water were to exist in general interstice S, water swellable tape 41 will swell across S2 and S3 and the yarn 34 or 36 which occupies sub-interstice S1 will swell thereacross. Thus although points C between tubes 23 and strength member 31, as described above, generally isolate sub-interstice S1 from water swellable tape 41, the occupation of sub-interstice S1 by one of the water swellable yarns ensures that sub-interstice S1 is protected against water migration. There will be, however, discrete sections of cable 10 where neither of yarns 34 or 36 will occupy sub-interstice S1. However, sufficient water blocking is assured because cable 10 is fabricated such that one or the other of yarns 34, 36 will occupy sub-interstice S1 at a suitable frequency, for example, about 250mm of cable length.

Figure 5 illustrates further embodiments of the present invention. For example, in a second embodiment of the present invention, a cable 100 includes a water swellable member comprising a single water swellable yarn 134 generally helically stranded about a compressive strength member 31. Yarn 134 will, according to its pitch, variously occupy positions in sub-interstices S1, S2, or S3, which positions are indicated as 134' in Figure 5. Yarn 134' will occupy sub-interstices S2 and S3 in other cross sections of cable 10.

Additionally, in a third embodiment of the present invention, yarn 134 is stranded about a respective buffer tube 23 but will, as in the first and second embodiments of the present invention, occupy sub-interstice S1 at certain intervals along the cable the yarn is stranded along buffer tube 23. In the third embodiment, central member 21 may be enlarged to allow yarns 34 and 36 to pass between tubes 23.

Furthermore, in a fourth embodiment of the present invention, a fiber optic cable 200 comprises a water swellable yarn 234 which is disposed in sub-interstice S1 whereby the yarn remains in sub-interstice S1 alongside member 31, as shown in Figure 6. In the fourth embodiment, yarn 234 is not stranded about compressive strength member 31 and will preferably not occupy positions in sub-interstices S2 or S3.

The foregoing embodiments are illustrative examples of the present invention, and persons of ordinary skill in the art will appreciate that other embodiments of the present invention can be practiced without departing from the scope of the appended claims. In any of the foregoing embodiments of the present invention, a given water swellable yarn may be advantageously secured to its respective compressive strength member 31 by an adhesive, a binder yarn, or other securing means. Additionally, the number and contents of tube and sheath sections 20, 40 can be modified without departing from the scope of the appended claims.

#### Claims

1. A fiber optic cable comprising tube and sheath sections with a general interstice formed therebetween and an interstitial assembly located in said general interstice;  
said tube section comprising an optical fiber, said sheath section comprising a sheath which surrounds said tube section, and said interstitial assembly including a water swellable member.

2. A fiber optic cable according to claim 1, wherein said water swellable member is generally helically stranded

3. A fiber optic cable according to claim 1, wherein said interstitial assembly defines sub-interstices within said general interstice; and said water swellable member is located in one of said sub-interstices.

4. A fiber optic cable according to claim 3, wherein said water swellable member is located in a radially inner sub-interstice.

5. A fiber optic cable according to any one of claims 1 to 4, wherein said interstitial assembly comprises a compressive strength member.

6. A fiber optic cable according to claim 5 as appended to claim 3, wherein said water swellable member is stranded whereby it varyingly occupies respective ones of said sub-interstices about said compressive strength member.

7. A fiber optic cable according to claim 5 or 6, wherein one of said sub-interstices is generally isolated from other said sub-interstices by said compressive strength member and said generally isolated sub-interstice receives a portion of said water swellable member.

8. A fiber optic cable according to claim 5 or 7, wherein said water swellable member is disposed alongside said compressive strength member not

stranded therearound.

9. A fiber optic cable according to any one of claims 5 to 7, wherein said interstitial assembly includes a plurality of water swellable members, said water swellable members being stranded about said compressive strength member.

10. A fiber optic cable according to claim 9, wherein said water swellable members are stranded in opposite directions.

11. A fiber optic cable according to any one of claims 1 to 7, wherein said water swellable member is stranded about a buffer tube of said tube section.

12. A fiber optic cable according to any one of claims 1 to 7, wherein said interstitial assembly comprises a plurality of generally helically stranded water swellable members.

14. A fiber optic cable according to claim 12, wherein said plurality of water swellable members comprise points of contact therebetween.

18. A fiber optic cable according to any one of claims 1-14, comprising a plurality of said interstitial assemblies each included in a respective one of a series of general interstices between said tube and sheath sections of said cable, each interstitial assembly including a compressive strength member, and a set of sub-interstices being defined, about each said compressive strength member, within the respective general interstice, each said set of sub-interstices comprising respective radially innermost sub-interstices, each said interstitial assembly including a water swellable member associated with a respective compressive strength member; and said water swellable members occupying respective positions in said innermost sub-interstices.

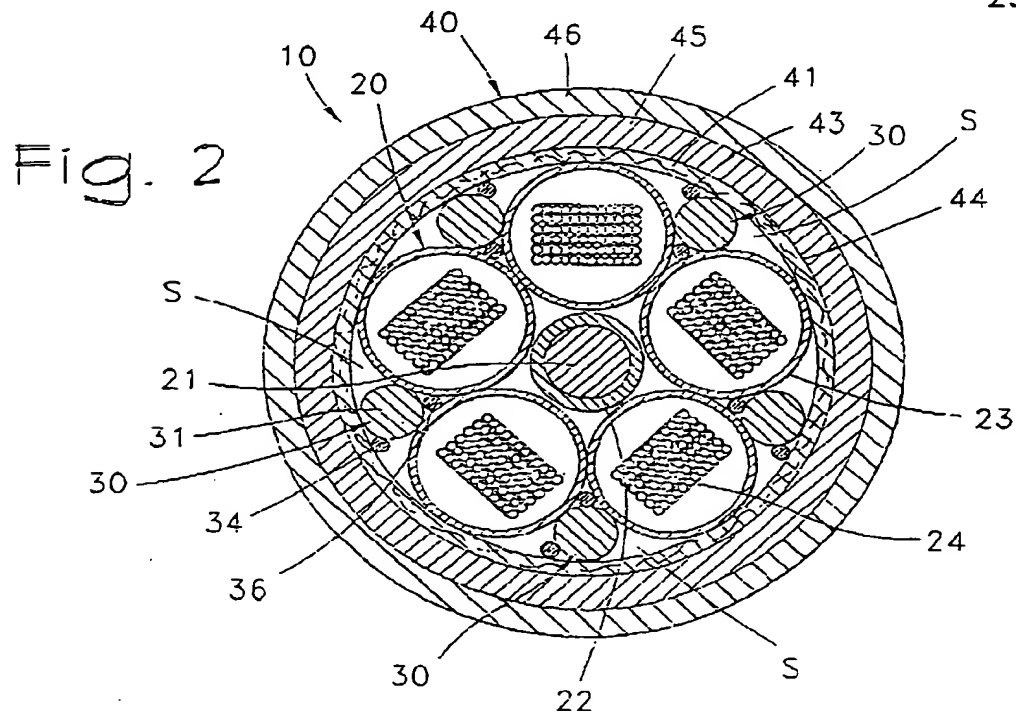
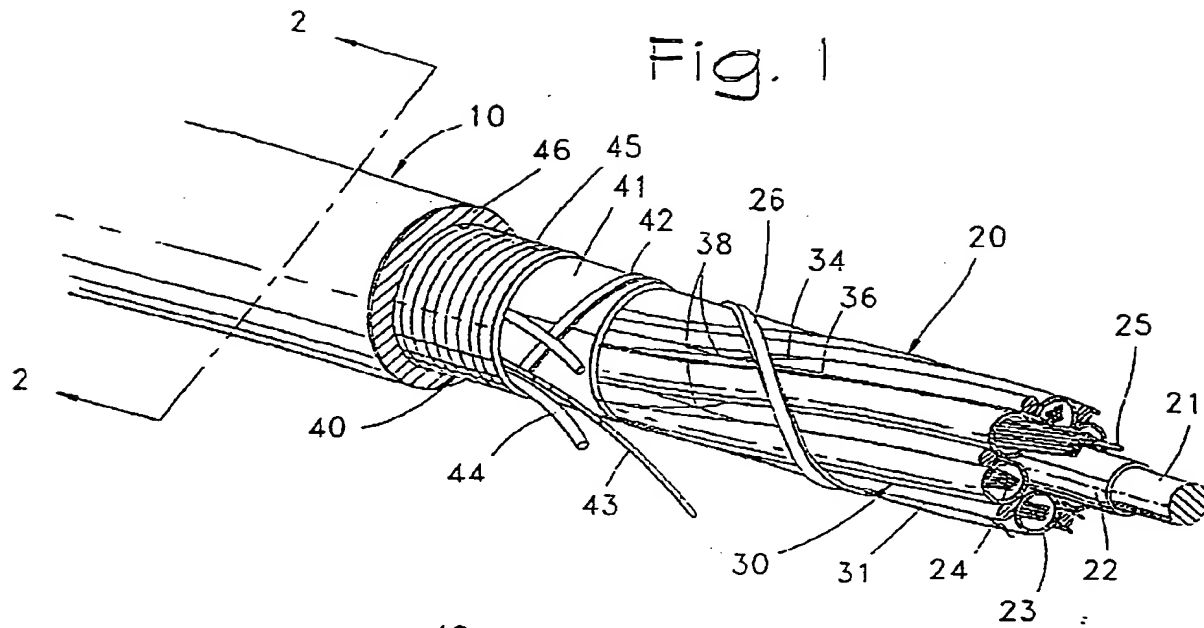


Fig. 3

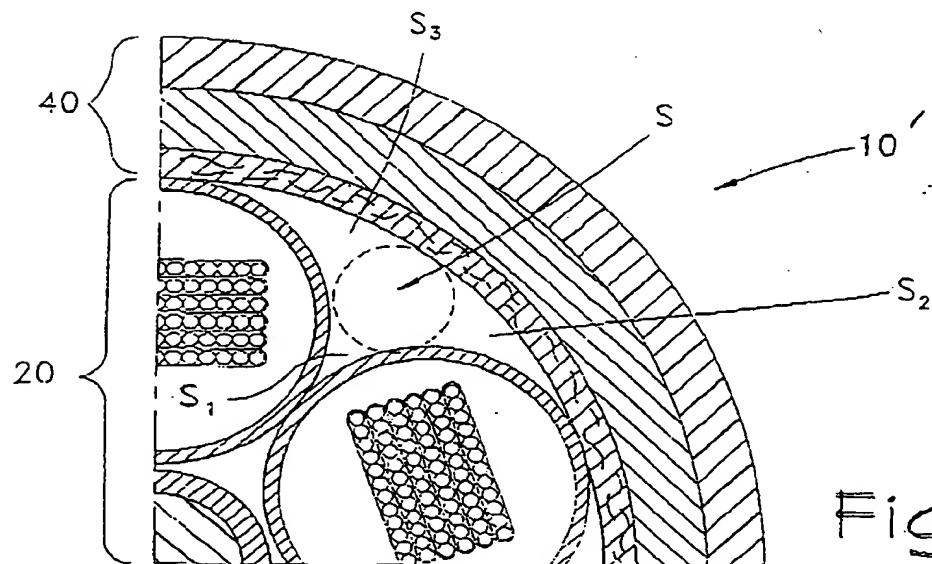
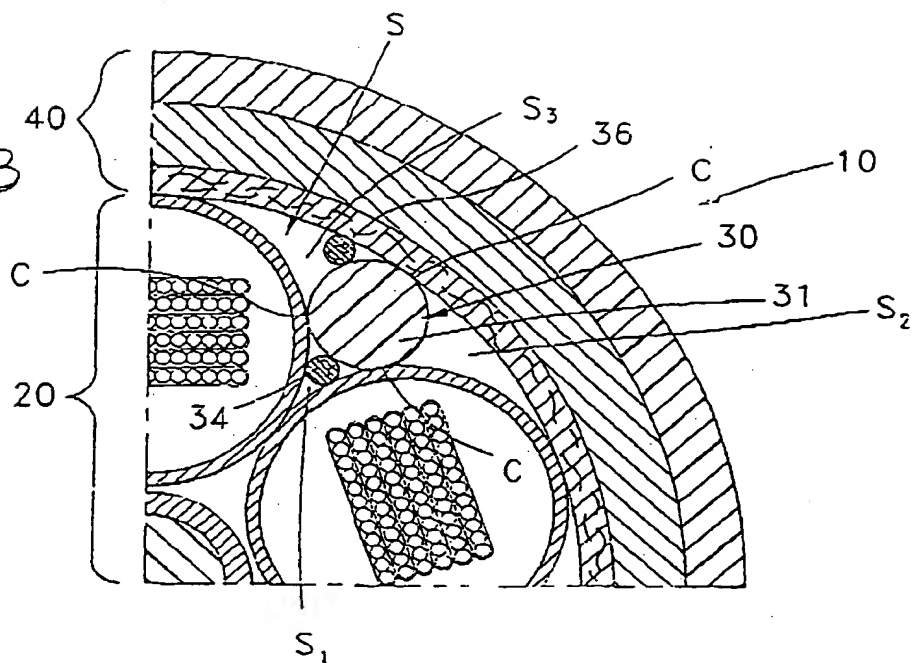
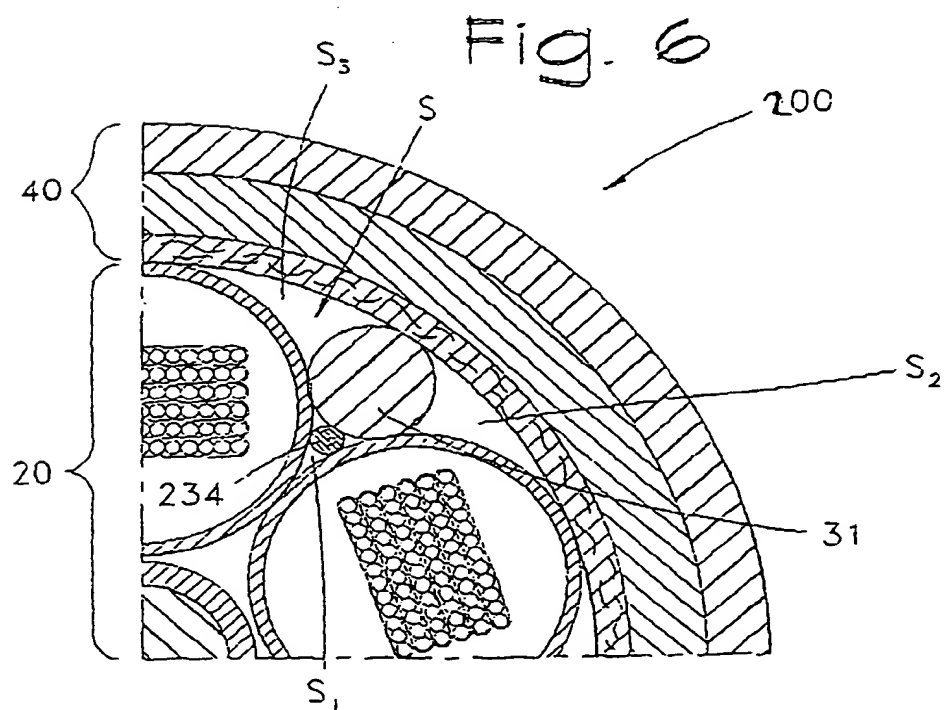
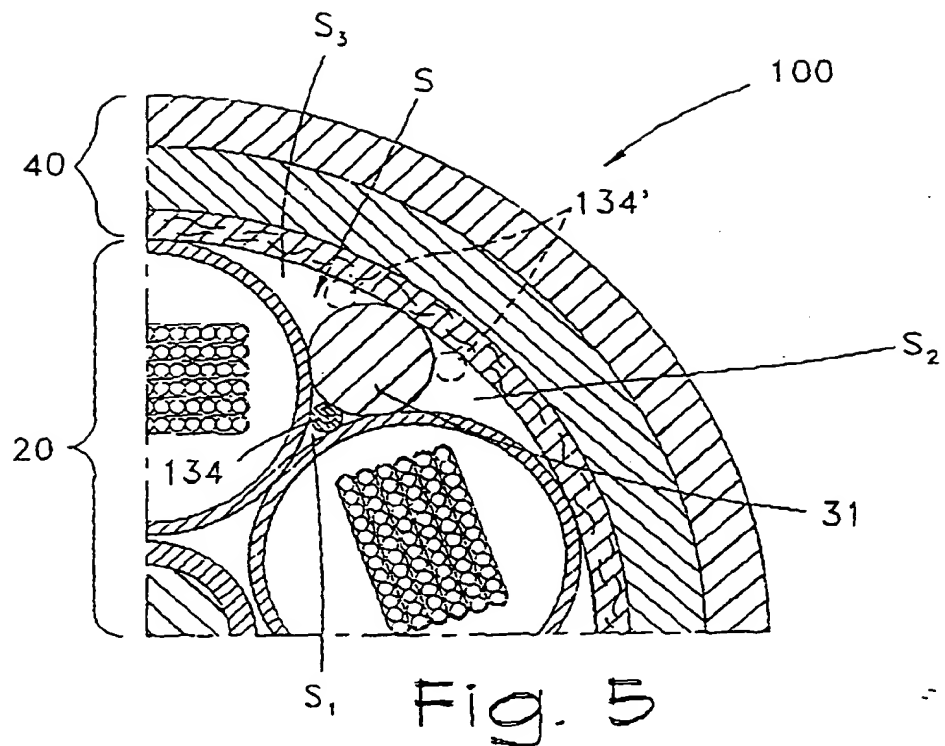


Fig. 4





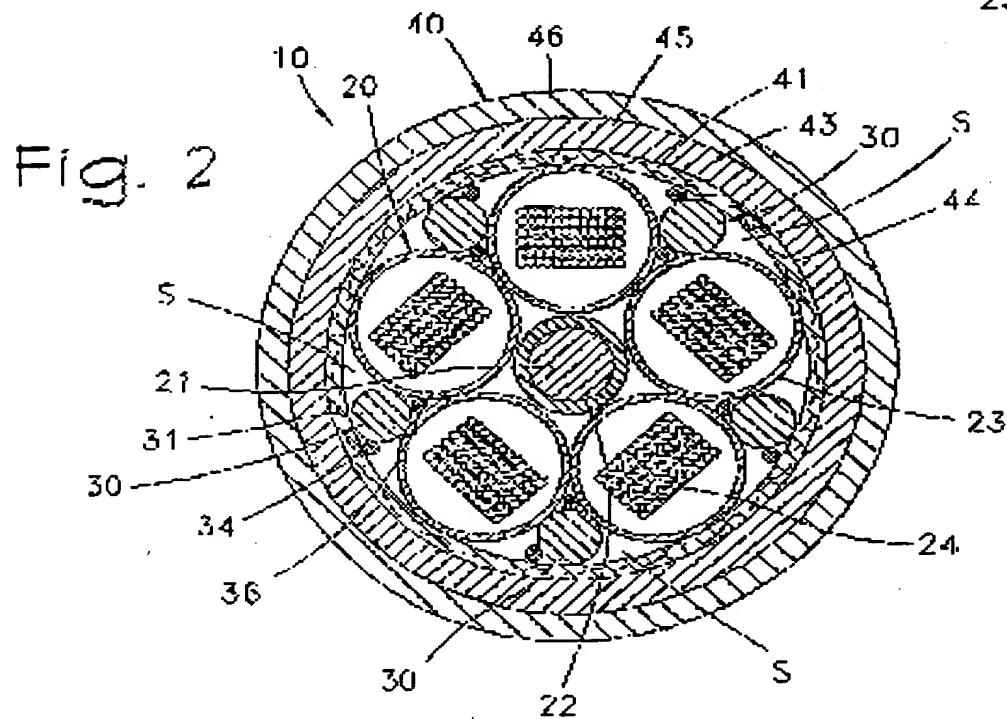
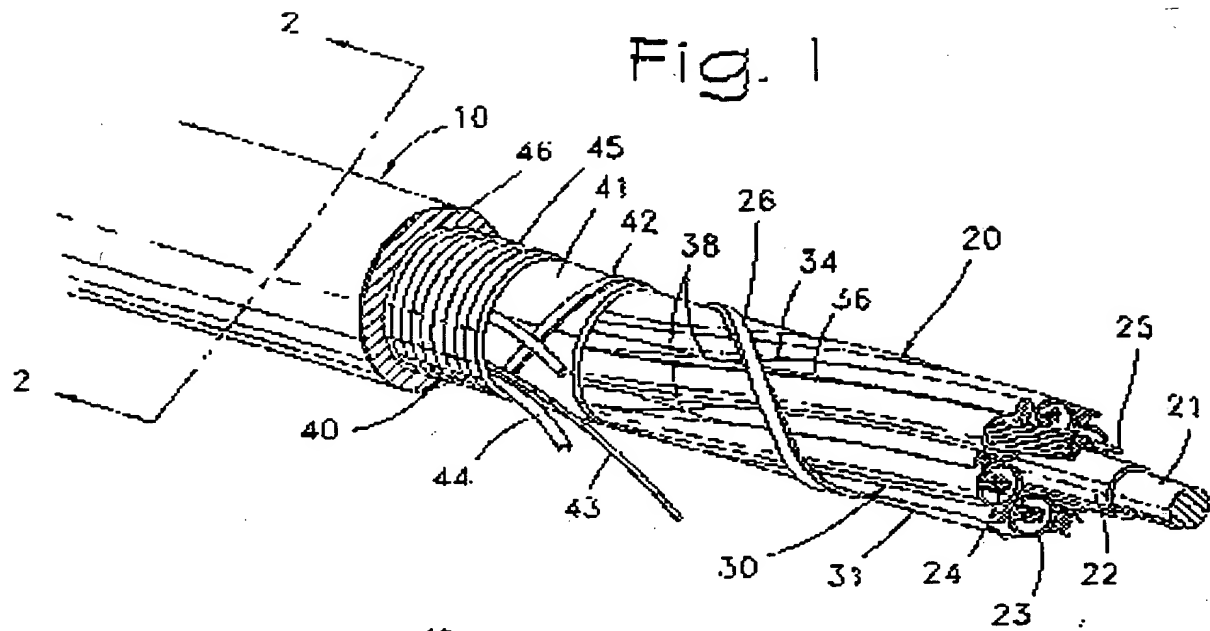


Fig. 3

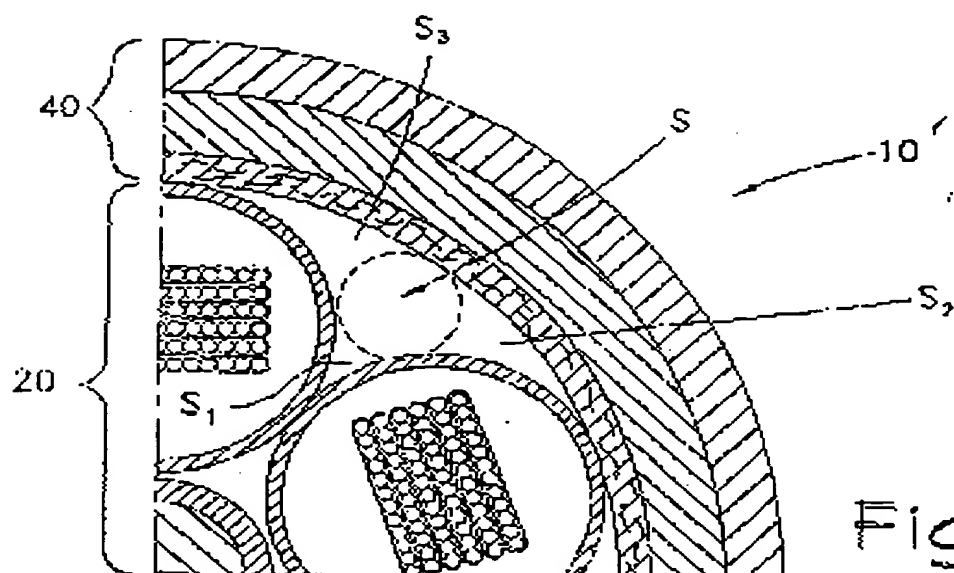
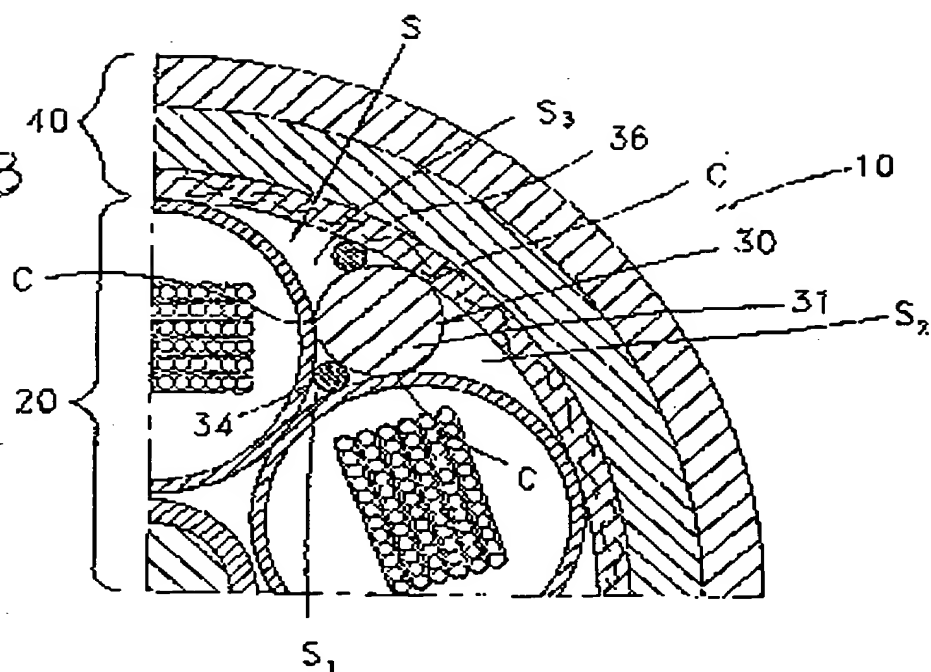
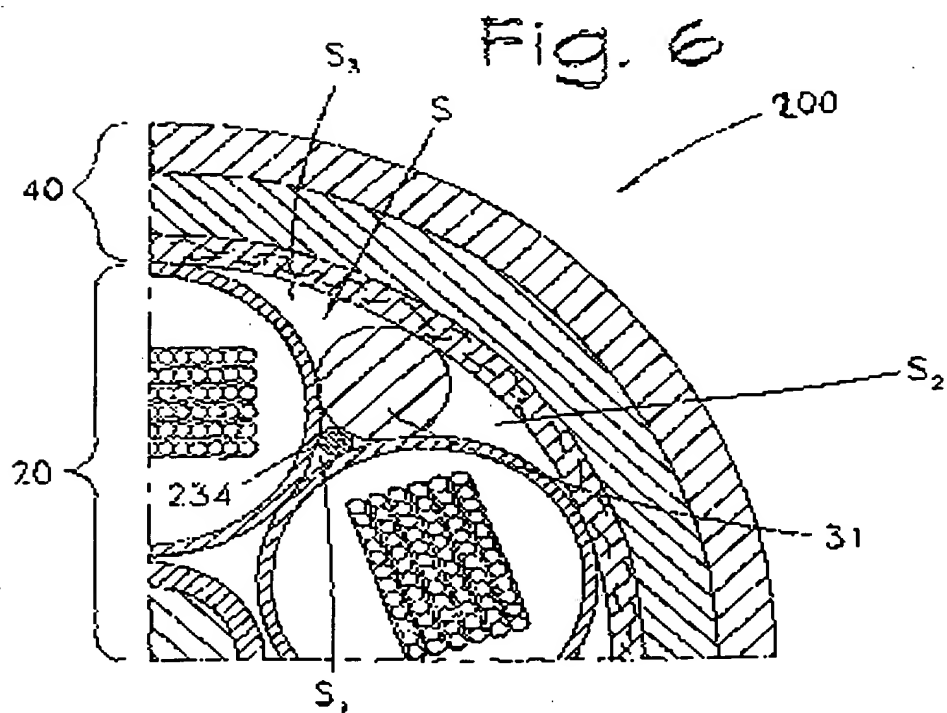
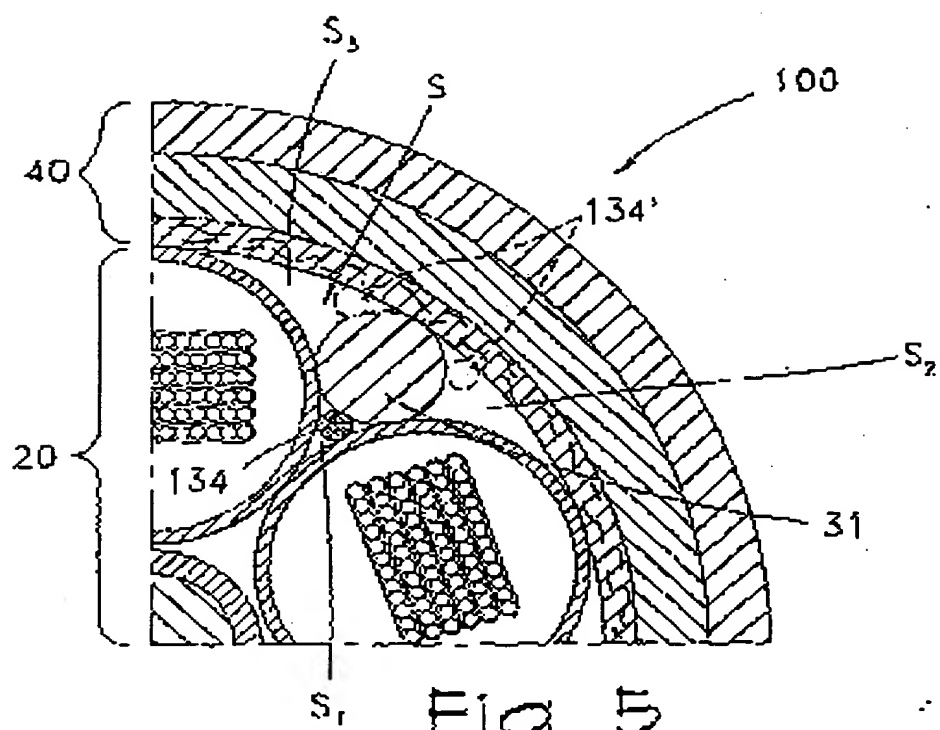
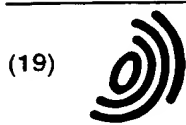


Fig. 4



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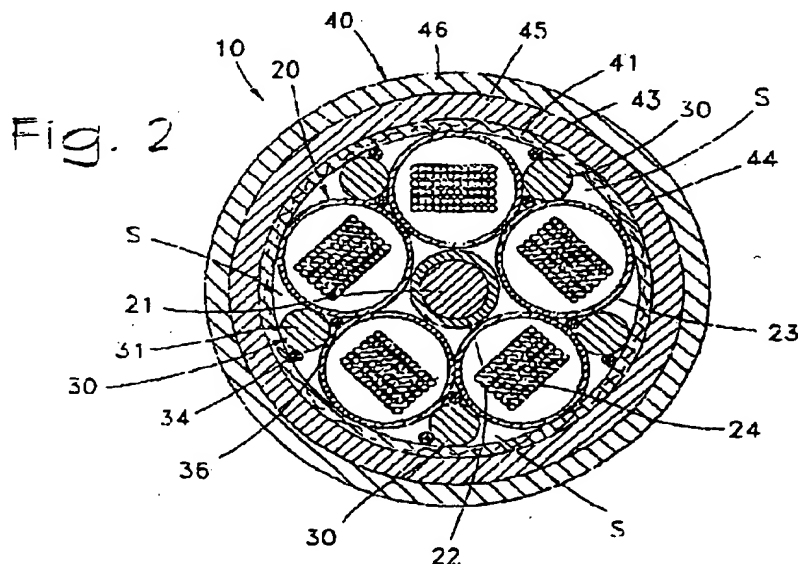
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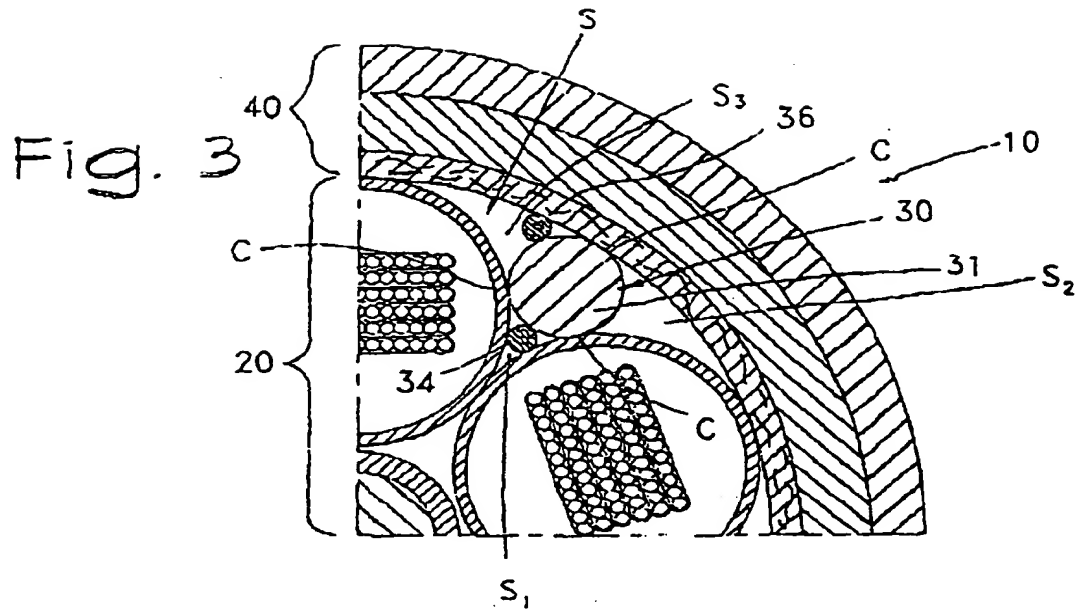
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### (54) Fibre optic cable

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**ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.**

EP 98 30 5130

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.  
The members are as contained in the European Patent Office EDP file on  
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## EUROPEAN SEARCH REPORT

Application Number  
EP 98 30 5130

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X A	EP 0 528 653 A (AMERICAN TELEPHONE & TELEGRAPH) 24 February 1993 * claims; figures *	1-4, 12, 14 5, 6, 9	G02B6/44
X	EP 0 777 141 A (AT & T CORP) 4 June 1997 * claims; figures *	1-3	
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The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			G02B
Place of search		Date of completion of the search	Examiner
THE HAGUE		23 February 1999	Pfahler, R
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